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B3H

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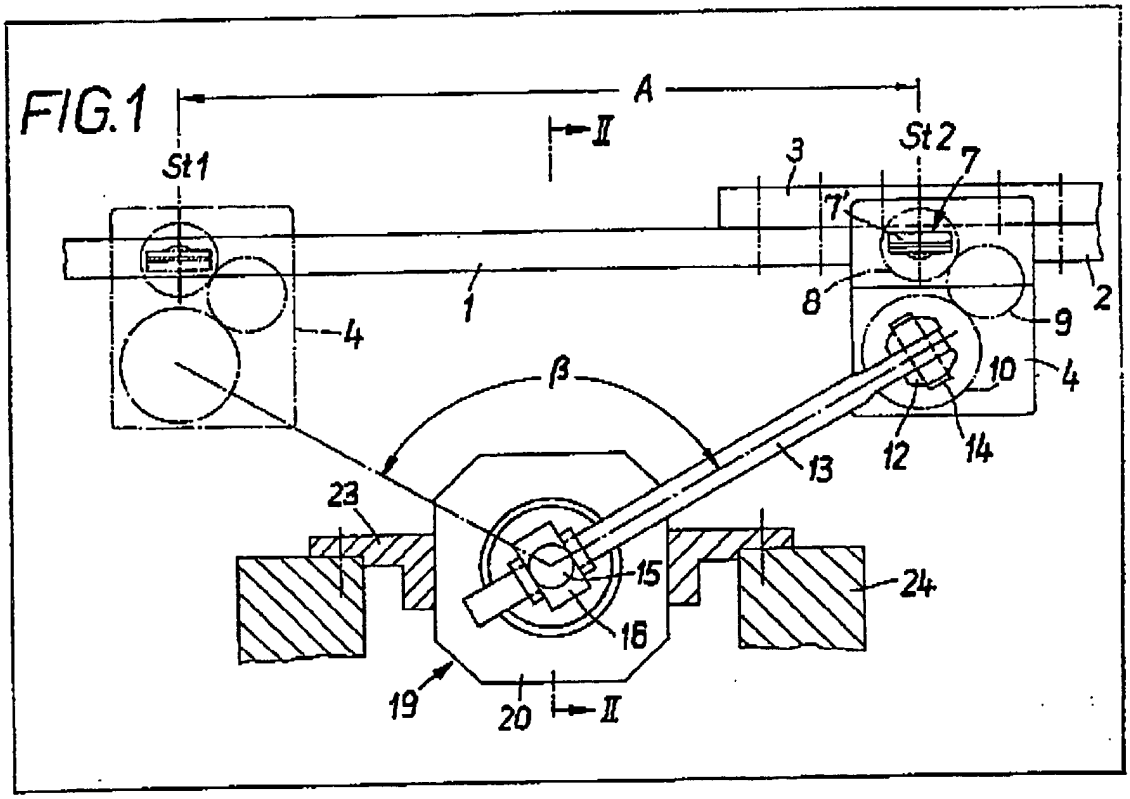
(54) Apparatus for Turning over Workpieces

(57) Apparatus for turning over workpieces comprising grippers 7 supported on gripper rails 1 which are movable towards and away from one another to enable the grippers to engage or disengage opposed edges of the workpiece. The gripper rails are also movable lengthwise and during such movement the grippers are rotated through 180° to turn the workpiece over. Each gripper is connected by gears 8, 9, 10 to one end of a guide rod 13 which is mounted at its other end in a ball joint 15, 16. The gripper is rotated as the result of rotation imparted to the guide rod by lengthwise movement of the gripper rail.



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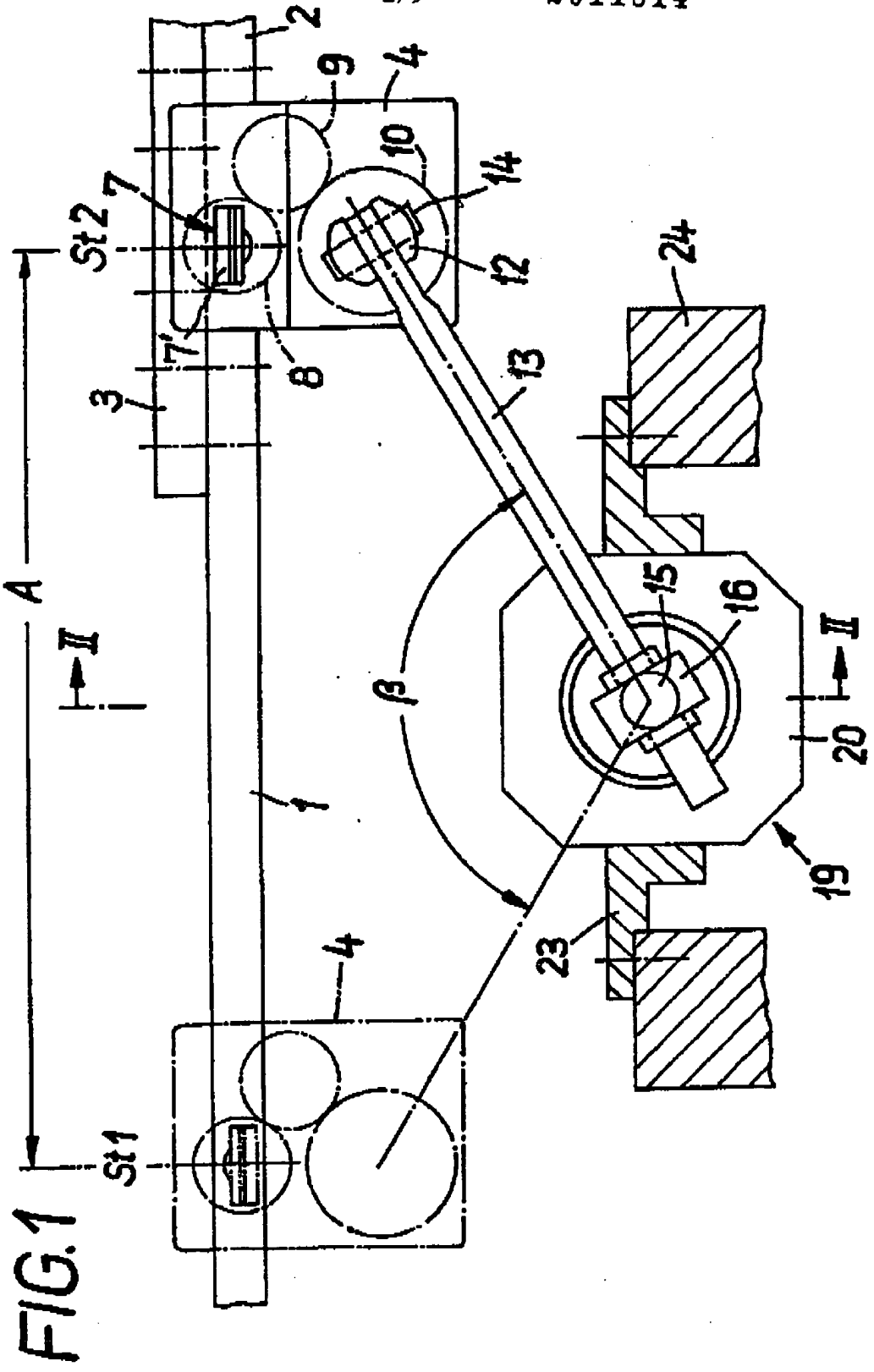

FIG.1

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FIG. 1a

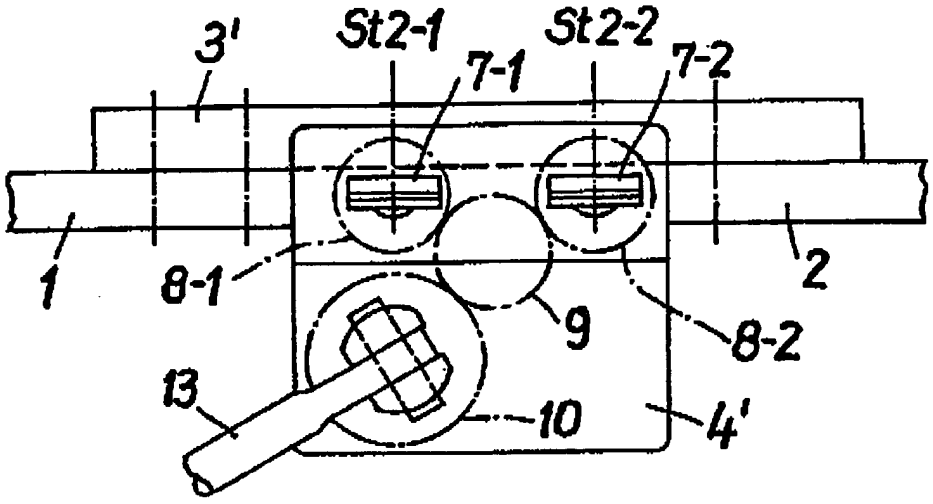
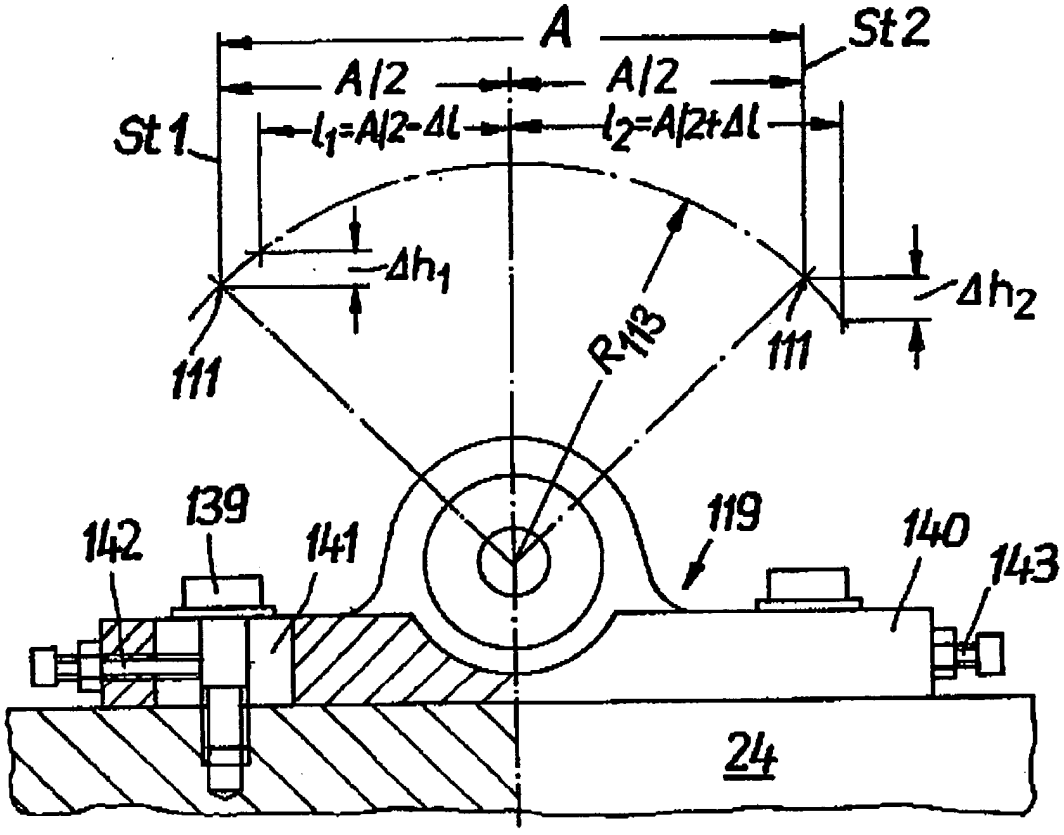


FIG. 7a



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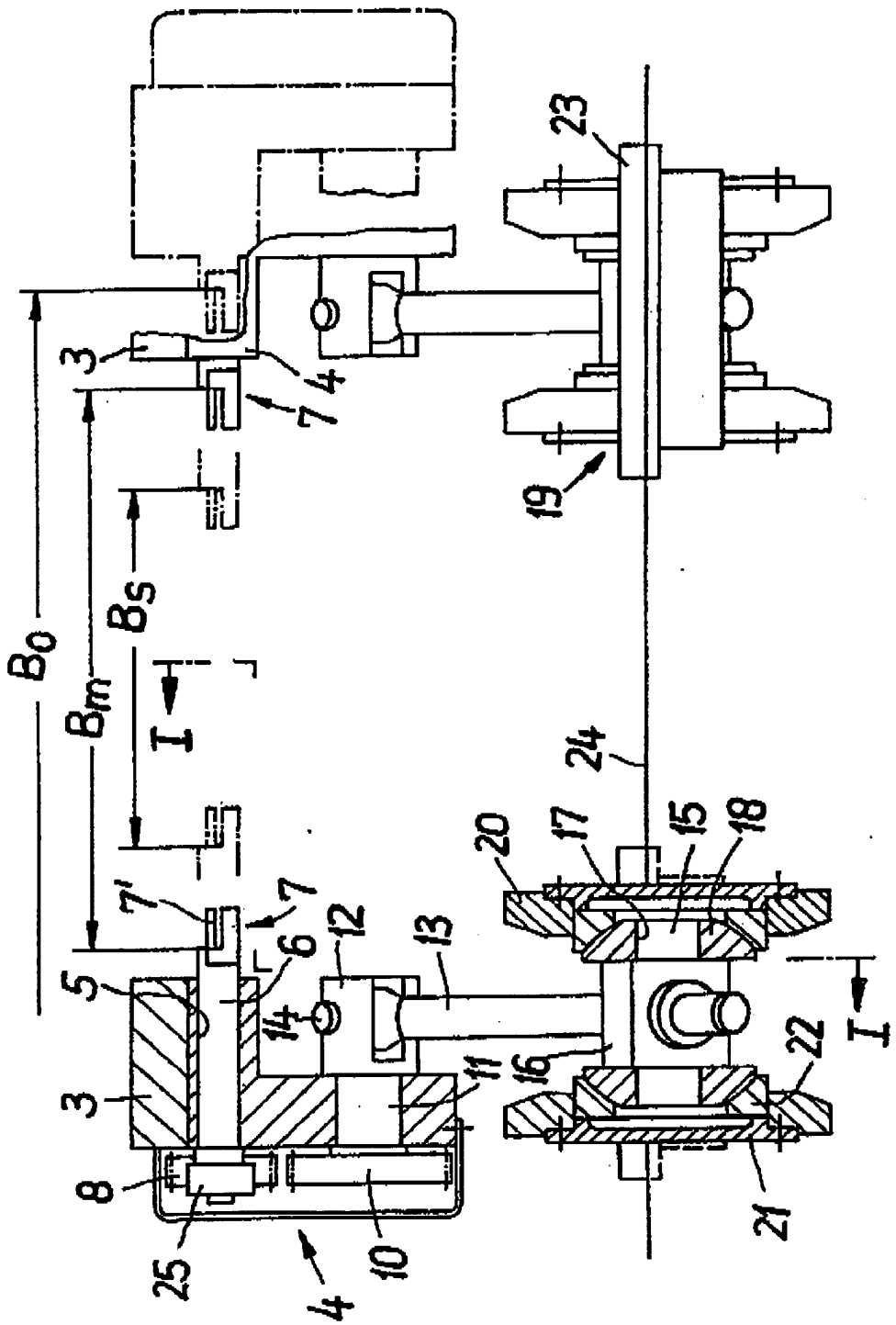

FIG.2

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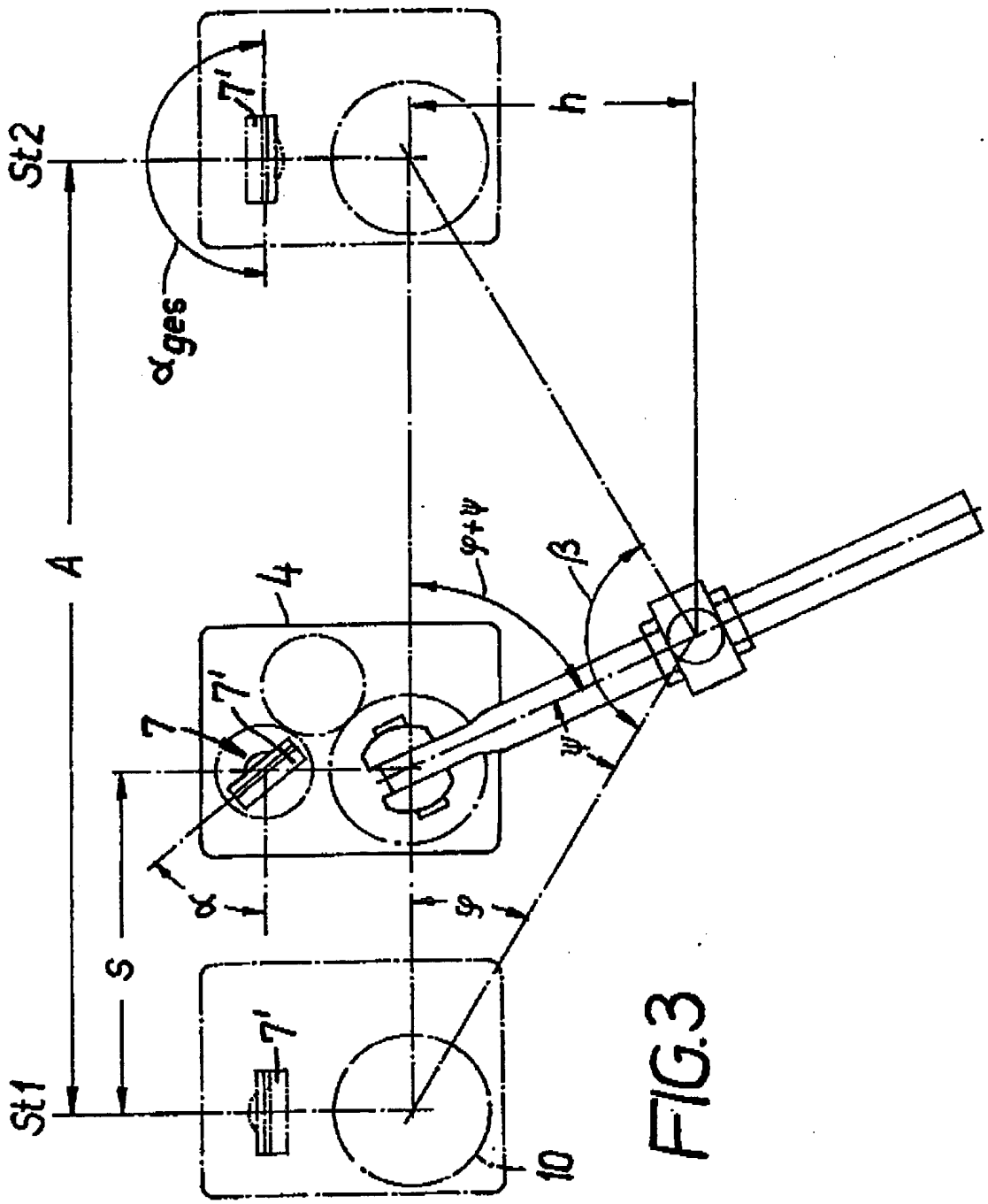

FIG.3

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FIG. 4

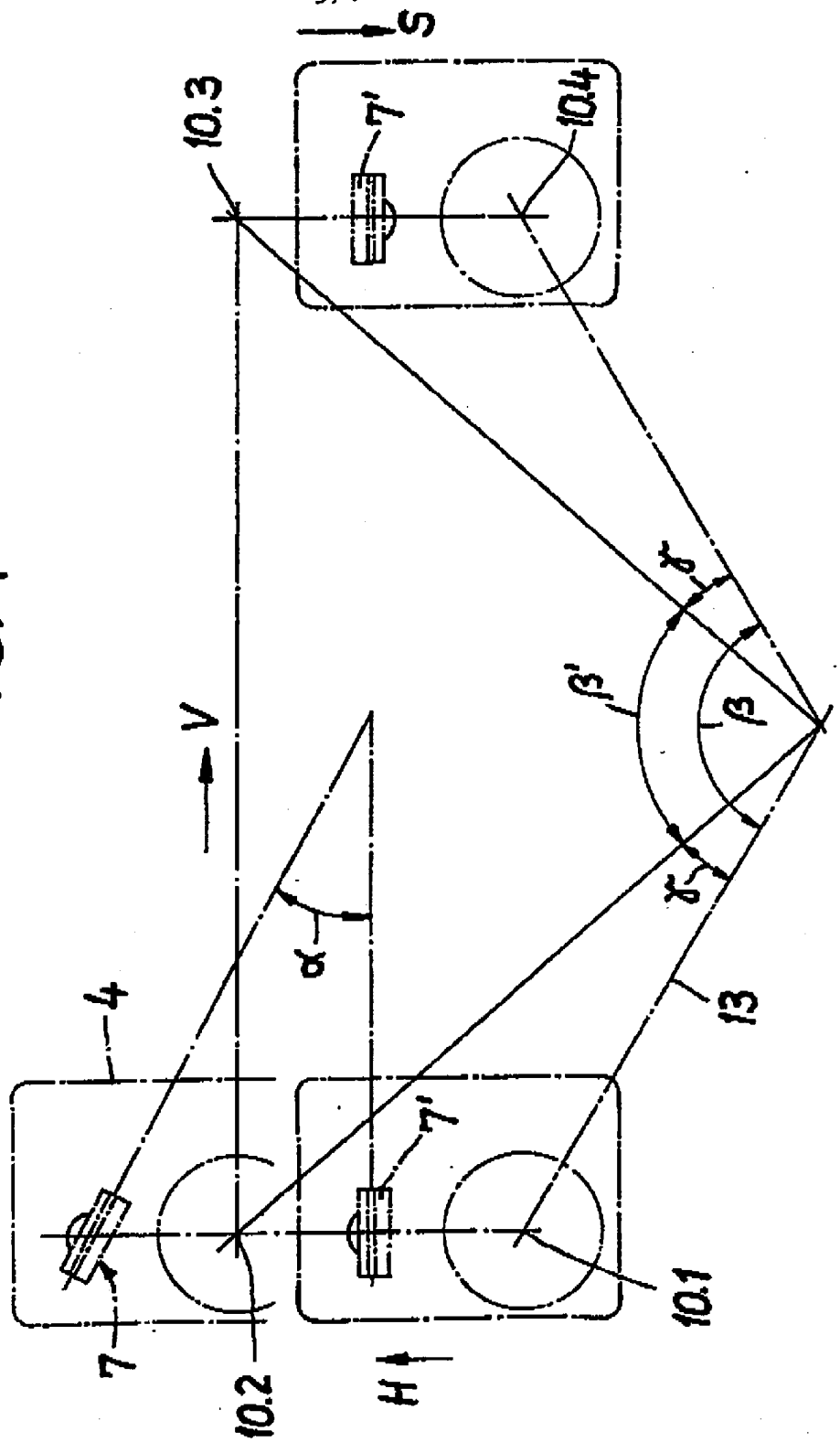

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FIG.5

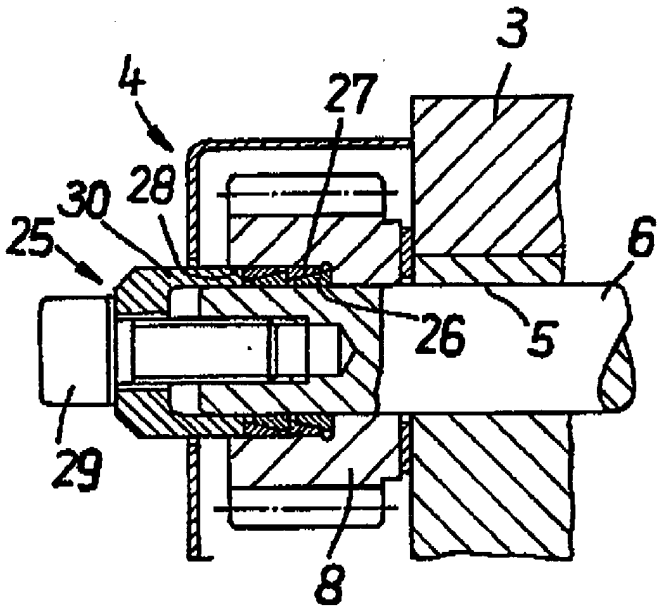

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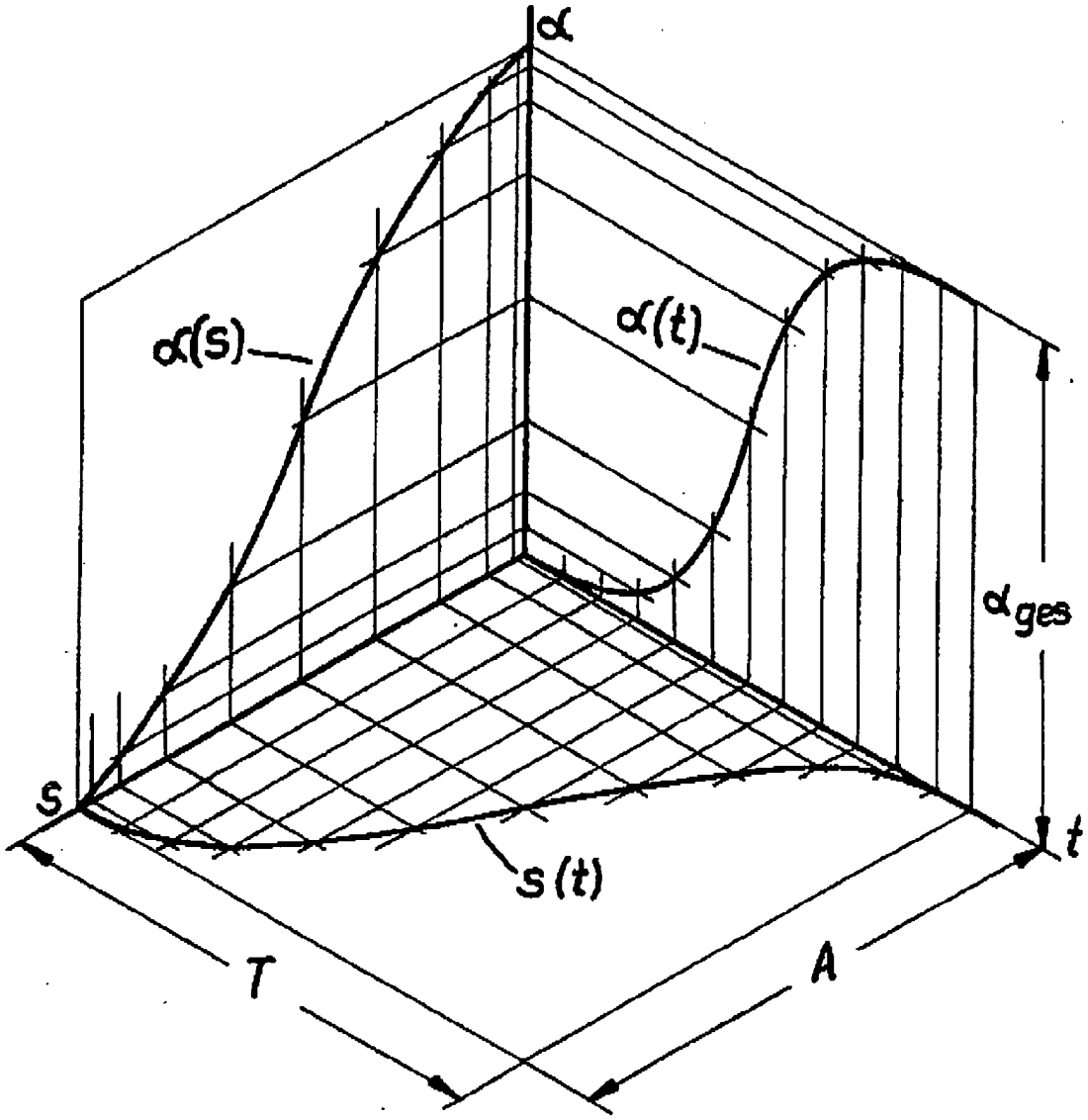
FIG. 6



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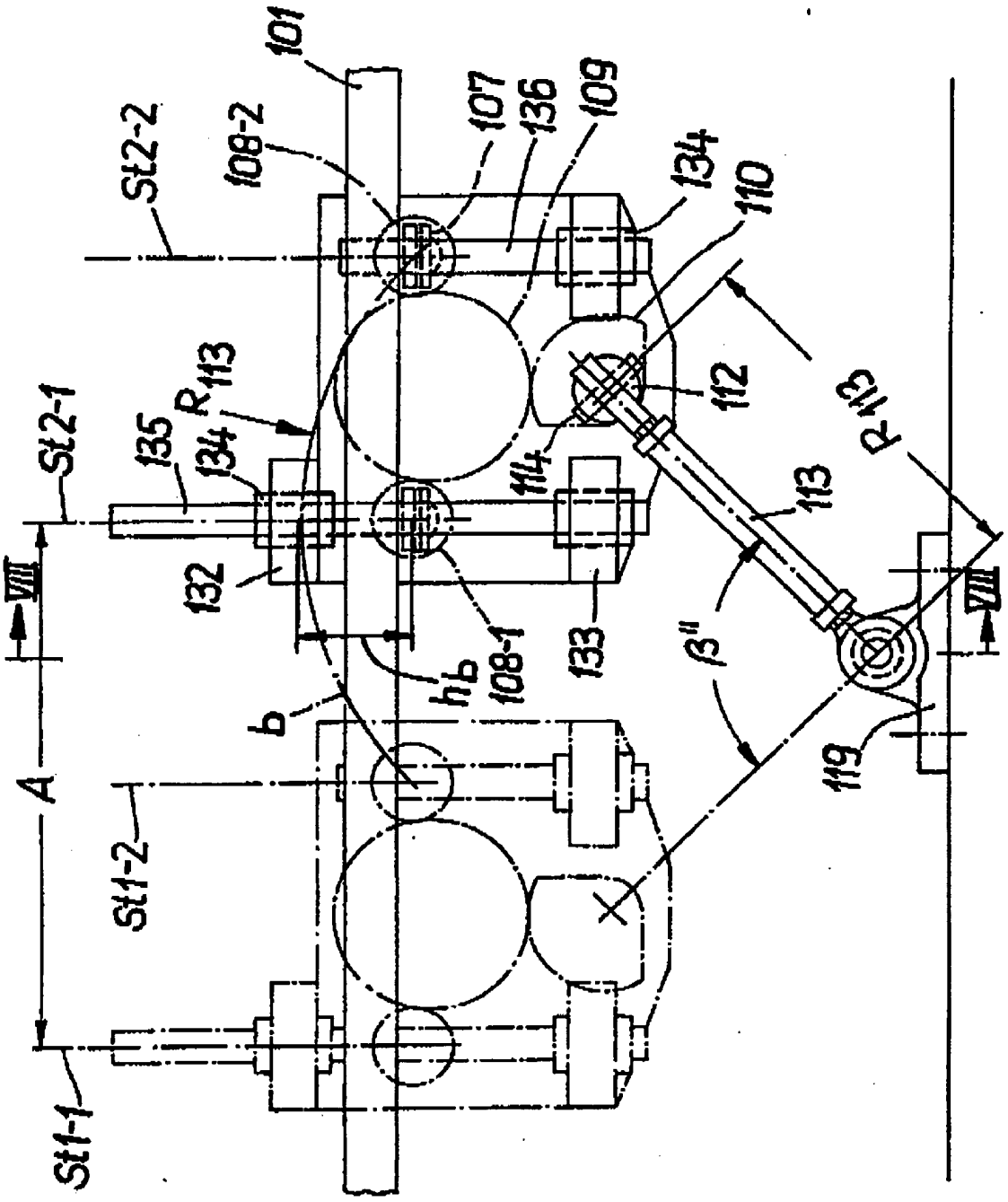
101
St2-2
108-2
107
136
109
134
110
112
R113
St2-1
135
134
R113
114
113
132
VIII
108-1
133
β''
VIII
hb
b
A
St1-2
119
St1-1

FIG. 7

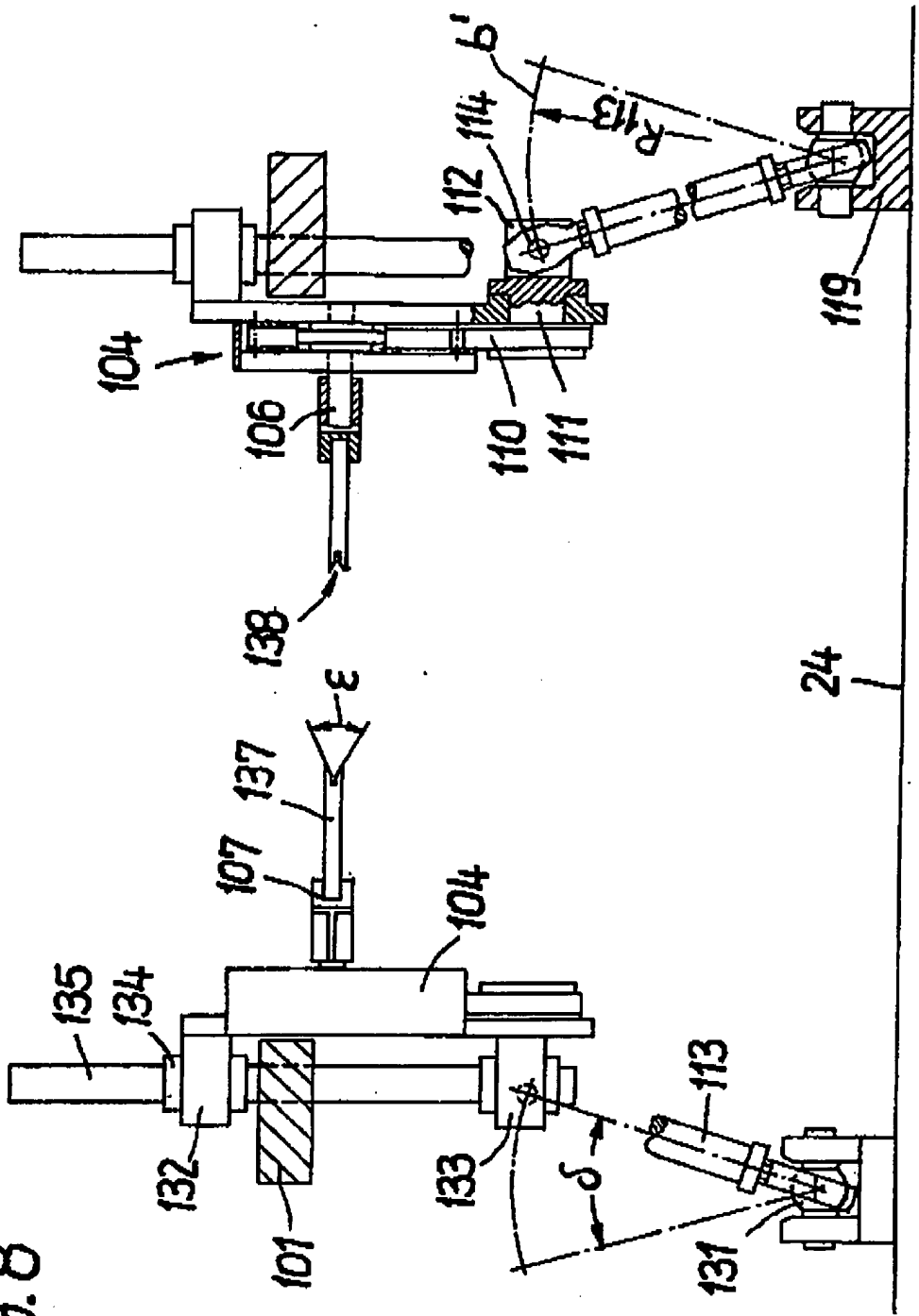
b'
R113
114
112
119
104
106
110
111
138
24
ε
137
107
104
135
134
132
133
δ
113
101
131

FIG.8

SPECIFICATION

Apparatus for Turning Over Workpieces

The invention relates to apparatus for turning over workpieces by means of turnover grippers mounted on shafts journalled in machine parts connected to the gripper rails, in which the shafts are guided from the gripper rails at least in the direction of feed of the gripper rails and are rotatable by individual transmission mechanisms.

Such apparatus is used in gang presses or between the presses of a transfer train when turning over the workpieces is rendered necessary for technological reasons or for compliance with the operations to be performed on the workpieces.

In a known turnover apparatus the grippers are connected by a shaft to a lever carrying a roller, the shaft being journalled in an extension piece fixed to the gripper rail. A spring arrangement exerts on the lever in the end positions of the gripper rails a torque in the direction of the desired rotation of the grippers. In the initial and in the other end position the roller is located on the flat part of a curved piece. In the direction of feed of the gripper rails the curved piece has a depression at about half the distance between stages, or half the path of feed, in which the lever carrying the roller assumes a vertical position. During the continued feed the roller is brought by a rise out of the depression, to the level of its initial position so that the lever, and a gripper connected to it, is rotated through a total angle of 90°. On return of the gripper rails the roller again passes through the depression so that the gripper is moved back into its initial position.

The main disadvantage of the known apparatus is that the relatively short lever connecting the roller to the gripper is started abruptly from the rest position into rotary movement which causes undesired impacts in the press which under some circumstances may necessitate reduction in the speed of the machine. Also the use of the described curved piece does not permit of provision of twinned tools at a working station. Also raising and lowering of the grippers, which is necessary for many operations, cannot be provided by this known apparatus.

The principal object of the invention is to make the movements during rotation of the grippers as free as possible from jerks and impacts. It is also intended that the grippers in the apparatus according to the invention should be capable of being raised and lowered and that two pairs of grippers can be provided per working station.

This object is achieved by th characteristics set out in claim 1. The invention is on the basis that the path of movement of the gripper rails should follow a higher sinoid or other suitable curve and be free of jerks and impacts and that the guide rods, which are mounted at one end on a fixed pivot in relation to the l ngitudinal movement of the gripper rails, are also rotated with approximate freedom from jerks and impacts. As the angle of rotation of the grippers is maintained in a fixed ratio to the angle of rotation of the guide rods by transmission gearing, the rotation of the grippers in accordance with the invention is also approximately free from jerks and impacts which permits the machine to be run at a higher speed. In the end positions the angle of rotation of the grippers changes less than the advance of the gripper rails so that the grippers have a particularly gentle change in angularity at the end positions of the gripper rails.

Further features of the invention are described in the subsidiary claims. Embodiments of the invention will now be further described with reference to the drawings, in which:—

Fig. 1 is a longitudinal section showing an apparatus for turning over workpieces,

Fig. 1*a* shows the turnover gearing of an apparatus according to Fig. 1 but including two turnover grippers and driving gears,

Fig. 2 is a section of the apparatus according to Fig. 1 along the line II—II in Fig. 1,

Fig. 3 is a diagram of the apparatus showing the extents of movement of the parts,

Fig. 4 shows the angular movements of the guide rods as the gripper rails are raised and lowered,

Fig. 5 shows a locating mechanism in the turnover gearing,

Fig. 6 is a diagram showing the relations between feed movement and time, rotation of the turnover grippers and feed movement and rotation of the turnover grippers and time,

Fig. 7 shows another embodiment of apparatus having guide rods with fixed pivots and turnover gears which can be raised and lowered,

Fig. 7*a* shows the attachment of the ball joint in the machine frame, and

Fig. 8 is a section of the apparatus shown in Fig. 7 along the line VIII—VIII in Fig. 7.

One embodiment of the apparatus for turning over workpieces includes two gripper rails 1. The gripper rails 1 may be prolonged by further rails 2 attached to the gripper rails 1 by coupling members 3. So-called turnover gearings 4 are attached to the members 3. The turnover gearings 4, which are of identical construction, and also the entire gripper system are disposed symmetrically. A shaft 6 is journalled in a bore 6 at the level of the gripper rails 1 and carried at the end facing the other gripper rail a turnover gripper 7 and at the other end a gear 8. The gear 8 is connected by an intermediate gear 9 to a driving gear 10. The driving gear 10 is coupled by a shaft 11 to rotate with a forked joint 12, in which the end of a guide rod 13 is retained by a pin 14. The guide rod 13 is also slidable in a slide 16 carrying two joint pins 15. The pins 15 are journalled in holes 17 in thrust pieces 18 having part-spherical surfaces. The thrust pieces 18 are accomm dated in a housing 19 having end walls 20 and carrying part-spherical sockets 22 held in place by covers 21. Th housing 19 is attachable by brackets 23 to different points along the width of the machine frame 24.

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The grippers 7 are shown in Fig. 2 in an intermediate position, in which they are spaced by the distance B_m. The closed position at spacing B_s and the open position at spacing B_o are also indicated in chain dotted lines. The transverse movements into the end positions made by the gripper rails to open and close the grippers have no effect on the rotational movement of the grippers so that these always occupy the same position during opening and closing.

In the initial position of the gripper rails 1, the grippers 7 occupy station St_1 and, at the end of the feed movement, as shown in Fig. 1, they occupy station St_2. For reasons of clarity only the gripper jaw 7', which is initially in the bottom position, is shown thicker than the other jaw.

During the feed movement of the gripper rails 1, the grippers 7 move parallel to them through the distance A between the stations. The upper ends of the guide rods 13, which are coupled to the fork joints 12, also move parallel to the movement of the gripper rails. The lower ends of the guide rods 13 slide through the sliders 16 and, after half the feed path A/2 of the gripper rails 1, are driven back again. The guide rods 13 thus move through the angle ϕ from their initial position about the centres of the ball joints 19. Each driving gear is rotated through the same angle ϕ. The rotary movement is tramitted through the intermediate gear, multiplied by the transmission ratio $i_{10/8}$, to the gear 8 and the gripper 7. When the gripper rails 1 have been fed through the distance s the grippers have rotated through the angle $\alpha = i_{10/8}\phi$. In the end position the guide rods have rotated through the angle β from their initial position and the grippers have rotated through the angle α_{ges}. In general the angle α_{ges} amounts to 180° or π radians, but in accordance with the form of the workpiece any other angle, for example for inclined delivery, can be selected, i.e. $\alpha_{ges} \gtrless \pi$ radians.

The angle β is determined by the dimensions A and h. It is preferably $120° = \frac{2}{3}\pi$ radians, but it may have a lower value. When $\beta = \frac{2}{3}\pi$ and $\alpha_{ges} = \pi$, the transmission ratio of the turnover gearing is given by:—

$$i_{10/8} = \frac{2/3}{1} = 1:1{,}5.$$

By mere interchange of change gears the transmission ratio $i_{10/8}$ can be easily varied to suit other limiting conditions.

Fig. 6 is a diagram showing the amount of feed s(t) of the gripper rails 1. The angle of rotation $\alpha(s)$ of the grippers 7 is also shown in dependence on the feed s, which is given by the relation:

$$\alpha = i\left(\frac{\beta}{2} - \arctan\frac{A/2 - s(t)}{h}\right)$$

It can be seen from this diagram that, surprisingly, the angle $\alpha(s)$ varies in the end positions of the gripper rails 1 more slowly than the feed s(t) of the gripper rails 1. Accordingly, the curve relating angle of rotations $\alpha(t)$ of the grippers 7 to time, which is shown as the third part of the diagram is a very smooth curve.

A requirement is sometimes imposed that the gripper rails 1 should perform, in addition, a vertical movement before and after the horizontal feed movement. This requirement exists for example, when the workpieces being shaped cannot be lifted entirely out of the lower forming tool or when the workpieces are required to be turned over above the plane of transport or above the level of the lower forming tool. The apparatus according to the invention can also be designed with advantage to provide such three dimensional feed for the gripper rails 1. Fig. 4 shows diagrammatically the movements which then take place. On raising the gripper rails 1 in the direction of the arrow H, the driving gear 10 connected to the guide rod is moved from its initial position 10.1 to the raised position 10.2. The guide rod 13 has then moved through an angle γ and the gripper 7 through a corresponding angle $\alpha = i_{10/8}\gamma$. During the feed movement of the gripper rails 1 (arrow V) the guide rod rotates through the angle β' and during lowering (arrow S) it rotates through a further angle γ, whereby $2\gamma + \beta' = \beta$.

To render possible precise positioning of the grippers 7 it is proposed in accordance with the invention to provide a gear 8 with a locating mechanism 25. The locating mechanism includes one or more pairs of conical rings 26, 27 disposed in a recess 28 in the gear 8. The rings 26, 27 are stressed, by a screw 29 engaging into the shaft 6 and thrust piece 30 to form a torque resistant unit between the gear 8 and the shaft 6.

As a variant of the construction described a single turnover gearing 4' can without difficulty also carry two grippers 7-1 and 7-2 (Fig. 1a). Such an arrangement in cooperation with further paired tools is, for example, useful when small workpieces are to be made on a gang press with a comparatively large distance between stages.

In another embodiment, the guide rods are not slidable in a pivotal joint. On the contrary they are pivoted at their lower ends and constituted by guide rods 113, which are variable in length in known manner by pairs of oppositely handed screw threads and are pivoted on respective ball joints 131 fixed to the machine frame 24. With this construction the shaft 111 journalled in the turnover gearing 104, one end of which is formed as a forked joint 112 and connected by a pin 114 to the upper end of the guide rod 113, does not execute a linear movement when moved by the gripper rail 101 (as in the first embodiment) but moves in an arcuate path b, at a radius R113 determined by the distance between the pivots of the guide rod 113. The grippers 107, and the workpiece are therefore raised by the distance h_b above the plane of transport. When the gripper rails 101 are fed by the distance A between the

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stations the guide rods 113 conveniently move through an angle $\beta''=90°$. The angle β'' may, however, be less.

This construction is of particular advantage when lifting of the workpieces is only required in or after station St1, for example in the case of twin tools at stations St1-1 and ST1-2, because the otherwise heavy cost of lifting and lowering the entire gripping rails is saved. The solution according to this embodiment presupposes that the workpieces are not required to be lifted vertically from the station but at a smaller angle, which is for example the case with ball shaped or slightly coned workpieces.

To enable the grippers 107 connected by the shafts 111 and the turnover gearing 104 to perform the vertical component of movement, the turnover gearing 104 carries an upper and two lower mountings 132, 133 respectively, which are supported by ball boxes 134 on longer and shorter columns 135, 136 fixed to the gripper rails 101.

The turnover gearing 104 is similar to the turnover gearing 4. In Fig. 7 two driving gears 108-1 and 108-2 are provided for the grippers 107, which are fixed to the gears 108-1 and 108-2, both of which mesh with an intermediate gear 109 which meshes in turn with a gear segment 110 which is driven by the shaft 111 from the guide rod 113.

During closing and opening of the grippers the turnover gearings 104 and all their parts including the grippers 107 move on a circular arc b' of radius R_{113}. To facilitate gripping the workpieces, the grippers 107 carry shaped parts 137 having angular openings 138 at their free ends, the angle ε of which is somewhat larger than the angle δ traversed during the closing movement.

The housing 119 of each ball joint 131 is attached by two screws 139 to the machine frame 24. The foot 140 of the housing 119 has two longitudinal slots 141 so that the foot can be displaced in the direction determined by these slots. Fine adjustment of the position of the housing 119 in the direction of feed of the gripper rails can be effected by two further screws 142, 143. If, when the screw 143 is free, the left hand screw 142 is turned to the right, the housing 119 will be moved to the left, i.e. the horizontal distance l_1 between the central vertical plane of the housing 119 and station St1 will be reduced by the amount Δl and the horizontal distance l_2 between the central vertical plane and station St2 will be increased by the amount Δl above half the distance A/2 between stations as shown in Fig. 7*a*. This increases the level of the rest position of the shaft 111, or the gripper 107, at station St1 by Δh_1 and reduces the level of the rest position of the shaft 111, or the gripper 107, at station St2 by Δh_2. With this embodiment therefore it is possible to set up different levels of grippers in relation to the rest position at the individual stations.

Claims

1. Apparatus for turning over workpieces by means of turnover grippers mounted on shafts journalled in machine parts connected to the gripper rails, in which the shafts are guided from the gripper rails at least in the direction of feed of the gripper rails and are rotatable by individual transmission mechanisms, characterised in that each transmission mechanism consists of a turnover gearing connected to the gripper rails and a guide rod, which is connected between the input shaft of the turnover gearing and a ball joint, and in that the shaft connected to the grippers is connected to the driving member of the turnover gearing.

2. Apparatus according to claim 1, characterised in that the turnover gearing is constituted by transmission gearing of such transmission ratio that the grippers have been rotated through 180° at the end of the feed movement of the gripper rails from their initial position.

3. Apparatus according to claims 1 and 2, characterised in that each turnover gearing includes in duplicate the driving member, the turnover gripper and the shaft connected thereto.

4. Apparatus according to claims 1 to 3, characterised in that the angular relationship of the grippers with respect to the turnover gearing is adjustable.

5. Apparatus according to claims 1 to 4, characterised in that each turnover gearing is fixed to a gripper rail and the guide rod is slidable in a slide held in the ball joint.

6. Apparatus according to claim 5, characterised in that the angle of rotation β of the guide rod about the centre of the ball joint between its initial and final positions is 120°.

7. Apparatus according to claims 1 to 4, characterised in that the guide rod is pivotable about the ball joint and the changeover gearing has mountings supported by ball boxes which are movable up and down at right angles to the gripper rails on columns fixed to the gripper rails.

8. Apparatus according to claim 7, characterised in that the angle of rotation β' of the guide rod about the centre of the ball joint between its initial and final positions is 90°.

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